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therefore of little use in fixing, in connexion with the well-known passage of Josephus, the date of Herod's last illness.

With regard to the eclipse of A.D. 30, its connexion with the date of the Crucifixion appears to rest only on the figurative expressions quoted by St. Peter from the prophet Joel: "The sun shall be turned into darkness and the moon into blood before . . ." As the purely astronomical portion of such speculations may rightly be considered to fall within the province of this Society, perhaps some Fellow possessing the leisure and requisite means, will oblige Dr. Stroud by undertaking an accurate computation of the eclipses in the above-mentioned years, with the data of the best modern tables.

Abstract of a Memoir in Vol. IX., Part IV. of the Cambridge Philosophical Society's Transactions, entitled, 'On the External Temperature of the Earth, and the other Planets of the Solar System.' By W. Hopkins, Esq. F.R.S. and V.P. C.P.S.

The author of this paper states in the outset that he was led into the researches therein contained in consequence of the interest excited by recent speculations involving the conditions of existence of organised beings,—conditions comprising heat, light, moisture, &c., of which he proposes to examine the one of temperature. He remarks that we have not the means of determining the actual superficial temperature of any planet besides our own, but that we know it must mainly depend (1) on the temperature of planetary space, (2) on the direct heat which the nearer planets receive from the Sun, and (3) from the modifications which result from their atmospheres, the positions of their axes of rotation, and the conductivity and specific heat of the substances forming their outer crusts,—modifications which may have a far greater influence than has been generally supposed.

He commences by general remarks and illustrations on the various modes by which heat may be transmitted, by complete or partial radiation, by conduction, or by convection, applying them, in the first place, to the Earth, and considering separately the mean temperature and the annual and diurnal variations.

"It is almost entirely by direct radiation that the solar heat reaches the Earth's surface, when the atmosphere is pure. . . . In the transference of the heat back again, all the other modes of transmission must be more or less effective, though we are altogether ignorant of their relative degrees of efficiency. It is, however, sufficient for us to know that none of them can be effective unless the temperature of the atmosphere decrease continually as we ascend from its lower to its upper regions . . . . . It will be my object to examine the data we possess for determining numerically what would be the effect of an *increase* or *diminution* of our atmosphere on terrestrial temperature, and also what is the actual effect of the Sun's heat on that temperature. We shall then be able to judge what may be the probable influence of similar causes on the temperatures of the other planets."

The author avails himself extensively of the previous researches of Poisson, presenting the results, however, in a simpler form. He first confirms, by several independent routes of inquiry, Poisson's resulting value of the temperature of the constituent particles of the atmosphere at its upper limit,

— 273° Centigrade,

remarking that this very low temperature is not to be confounded with that of surrounding space, but is to be understood to be that of the air at a point where its elasticity is lost, and it is reduced to the state of a fluid.

As his data for obtaining the decrement of temperature for a unit of height, he discusses the observations of Mr. Welsh in his four balloon ascents from Kew, in which were found severally,—

1852.	Height reached.	Decrement per 1000 Feet.
Aug. 17	19510 feet	3°·434 (F.)
,, 26	19100 ,,	3·440
Oct. 21	12640 ,,	3·431
Nov. 10	22930 ,,	3·205

Mr. Hopkins passes over the third of these results as obtained by a considerably less ascent, and attributes the discrepancy of the fourth to a difference of 19° (F.) in the temperature of the air at sea-level on Nov. 10. He remarks that such observations would alone enable us to form some estimate of the effect of an assigned increase or decrease in the atmosphere; an increase or decrease by a quantity corresponding to a space of 1000 feet at the surface, for example, sufficing to raise or lower the superficial temperature by 3° (F.), and proportionately for greater values.

As this is the most striking point in the memoir before us, we pass over the author's conclusions respecting distribution of temperature and periodic variations, to give his summary of results obtained with reference to the Earth, calling especial attention to his paragraph (3).

"(1) I have endeavoured to explain, as fully as possible, the manner in which the atmosphere produces its influence on the temperature of the Earth's surface; and to show that the temperature of the constituent particles of the atmosphere at its upper limit must be exceedingly low.

"(2) If as much atmosphere were removed from the Earth as now forms an inferior stratum of about 525 feet in thickness, the mean annual temperature of each point on the Earth's surface would be diminished by 1° (C) . . . . . If the thickness of the stratum removed were greater, the diminution of temperature would be greater in the same ratio . . . . An increase would produce an exactly similar, but opposite effect.

"(3) After explaining Poisson's method of treating the problem of terrestrial temperature, and his mode of estimating the direct effect of the solar heat radiating to the Earth. . . . I have shown that the *whole effect* of the solar heat on the mean value of this superficial temperature is equal to nearly twice the immediate effect, which was the object of Poisson's calculation, except in cases in which there may be a considerable horizontal transference of heat from local causes.

"(4) Assuming that the temperature of every part of the Earth's surface would be the same in the entire absence of the Sun's influence, I have estimated that temperature at $-39^\circ\cdot5$ (C). This must not be confounded with the temperature of that portion of stellar space in which the solar system now exists, a temperature which we have not the means of determining.

"(5) I have also shown that *annual inequalities* in the temperature of the lower stratum of the atmosphere are nearly equal in amount to those in the Earth itself at its surface, with exceptions similar to those mentioned in (3)."

The author next shows how that, if the Earth were placed at the distance of *Jupiter*, where the intensity of solar radiation is diminished in the ratio of 1 to 27 nearly, the mean annual temperature at the Equator would be $-36^\circ\cdot9$ (C) and at the Pole little more than $-39^\circ\cdot5$ (C), leaving out of consideration the effect which this reduction of temperature would have on the height, density, and transmissive quality of the atmosphere. The annual inequality at any latitude μ would be about

$$\pm 0^\circ\cdot6 \sin \mu \quad (\text{C}).$$

or sensibly negligible; and in passing from the Equator to the Poles the whole change of temperature would never exceed about 3° (C). The addition of 35,000 or 40,000 feet to the thickness of the Earth's atmosphere, if revolving in *Jupiter's* orbit, would unquestionably elevate her equatorial temperature to about that of our temperate zone at present. The principal difference between the Earth and *Jupiter* at this distance would arise from the greater density of the atmosphere about *Jupiter*, consequent on the greater mass; but the observations of Mr. Welsh, continued to a point at which the density of the atmosphere observed was reduced to less than one-half, lead to the conclusion that the transmissive power is nearly independent of the density, and that there would be no material difference in the rate at which the temperature would decrease in receding from the surface. "There seems reason to believe that *Jupiter* has an atmosphere much greater than that of the Earth, and it may be of such a thickness as entirely to counterbalance the defect of heat derived from the Sun by direct radiation. His climate must, however, differ from that of the planets nearer to the Sun, in the comparative absence of periodical variations. . . .

"The cases of the planets more remote than *Jupiter* are still more simple than that of *Jupiter* himself, since solar radiation can have no sensible effect whatever upon them. If the Earth were

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placed in the position of any one of these planets, and equilibrium of temperatures due to internal and external causes respectively were so far established as it is under existing conditions, her superficial temperature would, according to our previous calculations, be about $-39^{\circ}\cdot5$ (C); but if her atmosphere were increased to the requisite amount, this temperature might be increased, as we have seen, in any proposed degree, and so it must be with these remote planets themselves. Their superficial temperatures must be entirely uniform independently of variations due to local or temporary causes, and must depend on the quantity of atmosphere by which they may be respectively surrounded."

Treating next of the planet *Mars*, whose circumstances do not greater differ from those of the Earth, Mr. Hopkins calculates that the mean temperature of the Earth with her present atmosphere, moving in the orbit of *Mars*, would be at the Equator $-10^{\circ}\cdot7$ (C), and at the Pole $-34^{\circ}\cdot3$ (C); an additional depth of atmosphere to the extent of 15,000 or 20,000 feet would however suffice to raise the Equatorial temperature to about $15^{\circ}\cdot5$ (C) or 60° (F).

For the Earth, moving in the orbit of *Venus*, with her present atmosphere and inclination of axis, the author similarly finds as the mean temperature of the Equator 95° (C), and of the Pole $16^{\circ}\cdot5$ (C), both of which would doubtless be much modified by lateral transference. The maximum annual inequality at the poles is estimated at about ± 32° (C), but the inclination of axis usually adopted as existing for *Venus* herself would cause her seasons to be totally different from those of the Earth. Passing over the conclusions on this part of the subject, it is inferred, that a deduction of a superficial stratum of 25,000 feet of atmosphere would reduce the temperature of the equinoxial regions of *Venus* to that of the temperate regions of the Earth, that of her polar regions exceeding our tropical temperature by 12° or 13° (C). The direct heat of sunshine during the day would be about double that of our own. Certain further and allowable assumptions might materially modify these results, and permit the conclusion that large portions of the surface of *Venus* might be habitable by beings little better calculated than the human race to bear the extremities of heat and cold.

The author treats also of the case of our Moon, assuming her to be devoid of atmosphere, and with this application of his formulæ closes the subject.

Extract from a Letter received by the Astronomer Royal from Mr. Otto Struve, dated April 7.

"Has it been remarked by English astronomers that, this spring, the breadth of the obscure ring of *Saturn* was, on the following ansa, double (or at least one and six-tenths) of that on the preceding ansa? This feature was so striking on March 20, that it could be seen even by unpractised observers on the first glance."